UNIVERSITY OF SASKATCHEWAN
ELECTRICAL ENGINEERING 455.3

Assignment Quiz 1
September 22, 1997

(4)

Instructor: B.L. Daku
Time: 15 minutes
Note: No aids

Name:
Student Number:

1. Determine one of the angles of x (in degrees), where

$$x(n) = \sum_{n=0}^{3}\left[(2)^{\frac{n}{2}}\left(\cos\left(\frac{\pi}{4}n+\frac{\pi}{4}\right)+j\sin\left(\frac{\pi}{4}n+\frac{\pi}{4}\right)\right)\right]. \qquad (1)$$

$S = \frac{1-z^N}{1-z}$

$z = 2^{n/2}\left(\cos\left(\frac{\pi}{4}n+\frac{\pi}{4}\right)+j\sin\left(\frac{\pi}{4}n+\frac{\pi}{4}\right)\right)$

$= 2^{n/2} e^{j\left(\frac{\pi}{4}n+\pi/4\right)}$

$S = \frac{1-z^4}{1-z} \Leftarrow \frac{1-2^{4/2}e^{j\left(\frac{\pi}{4}4+\frac{\pi}{4}\right)}}{1-2^{1/2}e^{j\left(\frac{\pi}{4}+\pi/4\right)}}$

$= \frac{1-4\cdot e^{j5\pi/4}}{1-\sqrt{2}\,e^{j(\pi/2)}}$

$= \frac{1-4\cos(5\pi/4)-j4\sin(5\pi/4)}{1-\sqrt{2}\cos(\pi/2)-j\sqrt{2}\sin(\pi/2)}$

$= \frac{1+2\sqrt{2}+j2\sqrt{2}}{1-j\sqrt{2}}$

$= \frac{3.8284+j2.8284}{1-j1.4142}$

$= \frac{4.7599\angle 36.457^\circ}{.3333\angle -.471^\circ}$

$= 8.2444\angle -18.279^\circ$

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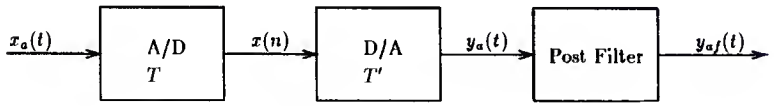
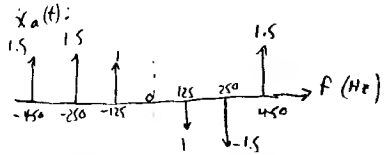
1. Consider the simple signal processing system shown in the following figure. The sampling periods of the A/D and D/A converters are $T = 5$ ms and $T' = 1$ ms, respectively. Determine $x(n)$, $y_a(t)$ and $y_{af}(t)$ of the system, if the input is

$$x_a(t) = 3\cos(900\pi t) + 2\sin(250\pi t) + 3\sin(500\pi t) \qquad (1)$$

The postfilter removes any frequency component above $\frac{F_s}{2}$, where $F_s = \frac{1}{T}$.



A/D:
$T = 5$ ms
$\therefore f_s = 200$ samples/s



$f_f = \frac{f_s}{2} = 100$

$t = \frac{n}{f_s}$

$X(n) = 3\cos\left(2\left(\frac{450}{200}\right)\pi n\right) + 2\sin\left(\left(\frac{125}{200}\right)2\pi n\right) + 3\sin\left(\left(\frac{250}{200}\right)2\pi n\right)$

$= 3\cos\left(2\pi n\frac{9}{4}\right) + 2\sin\left(2\pi n\left(\frac{5}{8}\right)\right) + 3\sin\left(\left(\frac{5}{4}\right)2\pi n\right)$

$= 3\cos\left(2\pi n\left(\frac{1}{4}\right)\right) + 2\sin\left(2\pi n\left(\frac{-3}{8}\right)\right) + 3\sin\left(\left(\frac{1}{4}\right)2\pi n\right)$

$X(n) = 3\cos(2\pi n\frac{1}{4}) - 2\sin\left(2\pi n\left(\frac{3}{8}\right)\right) + 3\sin\left(2\pi n\left(\frac{1}{4}\right)\right)$ (3)

$n = t\cdot f_s$ (+1)

$\therefore y_a(t) = 3\cos\left(2\pi t\frac{200}{4}\right) - 2\sin\left(2\pi t\frac{200}{2}\left(\frac{3}{8}\right)\right) + 3\sin\left(2\pi t\frac{200}{4}\right)$ (2)

$y_a(t) = 3\cos(100\pi t) - 2\sin(150\pi t) + 3\sin(100\pi t)$

50 Hz 75 Hz 50 Hz

* filter removes freq above $\frac{F_s}{2} = \frac{1}{T\cdot 2} = 100$ Hz; * all freq of $y_a(t)$ are below (5)

$y_{af}(t) = 3\cos(100\pi t) - 2\sin(150\pi t) + 3\sin(100\pi t)$
$= y_a(t)$ (3)